A/RE

Please type a plus sign (+) inside this box → ⊞

PTO/SB/50 (08-00)
Approved for use through 12/30/2000. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

REISSUE PATENT APPLICATION TRANSMITTAL

Address to:

Assistant Commissioner for Patents
Box Reissue
Washington, DC 20231

Attorney Docket No.	93698-US
First Named Inventor	Jason T. Sterne
Original Patent Number	5,818,839
Original Patent Issue Date (Month/Day/Year)	10/06/98
Express Mail Label No.	

APPLICATION FOR REISSUE OF: (Check applicable box) [X] *Utility Patent* [ ] *Design Patent* [ ] *Plant Patent*

APPLICATION ELEMENTS (37 CFR 1.173)

1. [X] Fee Transmittal Form *(PTO/ SB/ 56)* *(Submit an original, and a duplicate for fee processing)*
2. [ ] Applicant claims small entity status. See 37 CFR 1.27.
3. [X] Specification and Claims in double column copy of patent format *(amended, if appropriate)*
4. [X] Drawing(s) *(proposed amendments, if appropriate)*
5. [X] Reissue Oath/Declaration (original or copy) *(37 C.F.R. § 1.175) (PTO/SB/51 or 52)*
6. Original U.S. Patent currently assigned?

   [X] Yes [ ] No

   (If Yes, check applicable box(es))

   [ ] Written Consent of all Assignees *(PTO/SB/53)*

   [X] 37 C.F.R. § 3.73(b) Statement [ ] Power of Attorney (PTO/SB/96)

ACCOMPANYING APPLICATION PARTS

7. [X] Statement of status/support for all changes to the claims. See 37 CFR 1.173 (c).
8. [ ] Original U.S. Patent for surrender
   - [ ] Ribboned Original Patent Grant
   - [ ] Statement of Loss (PTO/SB/55)
9. [ ] Foreign Priority Claim *(35 U.S.C. 119)* *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] English Translation of Reissue Oath/Declaration *(if applicable)*
12. [X] Preliminary Amendment
13. [ ] Return Receipt Postcard *(MPEP 503)* *(Should be specifically itemized)*
14. Other: .....

15. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* (Insert Customer No. or Attach bar code label here) or [X] *Correspondence address below*

Name	Marks & Clerk				
Address	P.O. Box 957, Station B				
City	Ottawa	State	Ontario	Zip Code	K1P 5S7
Country	Canada	Telephone	613 236-9561	Fax	613 230-8821

NAME (Print/Type)	George M. MacGregor	Registration No. (Attorney/Agent)	37,547
Signature		Date	October 4, 2000

PTO/SB/56 (08-00)
Approved for use through 12/30/2000 OMB 0651-0033
U S Patent and Trademark Office, U.S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

REISSUE APPLICATION FEE TRANSMITTAL FORM

Docket Number (Optional): 93698-US

Claims as Filed - Part 1

Claims in Patent		Number Filed in Reissue Application	(3) Number Extra	Small Entity Rate	Small Entity Fee		Other than a Small Entity Rate	Other than a Small Entity Fee
(A) 12	Total Claims (37 CFR 1 16(j))	(B) 11	**** =	x $____ =		or	x $____ =	
(C) 2	Independent claims (37 CFR 1 16(i))	(D) 2	* =	x $____ =			x $____ =	
				Basic Fee (37 CFR 1.16(h))	$____			$ 710.00
				Total Filing Fee	$		OR	$ 710.00

Claims as Amended - Part 2

	(1) Claims Remaining After Amendment		(2) Highest Number Previously Paid For	(3) Extra Claims Present	Small Entity Rate	Small Entity Fee		Other than a Small Entity Rate	Other than a Small Entity Fee
Total Claims (37 CFR 1.16(j)	*** 11	MINUS	** 20	* =	x $____ =			x $____ =	
Independent Claims (37 CFR 1.16(i))	*** 2	MINUS	***** 2	=	x $____ =			x $____ =	
					Total Additional Fee	$		OR	$

* If the entry in (D) is less than the entry in (C), Write "0" in column 3.

** If the "Highest Number of Total Claims Previously Paid For" is less than 20, Write "20" in this space.

*** After any cancellation of claims.

**** If "A" is greater than 20, use (B - A); if "A" is 20 or less, use (B - 20).

***** "Highest Number of Independent Claims Previously Paid For" or Number of Independent Claims in Patent (C).

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ Please charge Deposit Account No. _____ in the amount of _____.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any additional fees under 37 CFR 1.16 or 1 17 which may be required, or credit any overpayment to Deposit Account No. 13-1717.
A duplicate copy of this sheet is enclosed.

☒ A check in the amount of $ 710.00 to cover the filing / additional fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

October 4, 2000
Date

Signature of Applicant, Attorney or Agent of Record

George M. MacGregor (37,547)
Typed or printed name

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231 DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Jason T. Sterne

For	:	*TIMING REFERENCE FOR SCHEDULING DATA TRAFFIC ON MULTIPLE PORTS*
Patent No.	:	**5,818,839**
Issued	:	October 6, 1998
Examiner	:	K. Vanderpuye
Art Unit	:	2732
Our File	:	**93698-US**

October 4, 2000

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231
U. S. A.

TRANSMITTAL LETTER

Sir:

In connection with the above-captioned application, please find enclosed for filing:

- Reissue Patent Application Transmittal
- Reissue Application Fee Transmital Form
- Reissue Application Declaration by the Inventor
- Statement Under 37 CFR 3.73(b)
- Specification
- Drawings
- Statement of Status/Support for changes to the claims
- Preliminary Amendment
- Cheque in the amount of $710.00

Respectfully submitted,

George M. MacGregor, Reg. No. 37,547
Marks & Clerk
P.O. Box 957, Station B
280 Slater Street, Suite 1800
Ottawa, Ontario, Canada
K1P 1C2

Telephone No.: (613) 236.9561
Facsimile No.: (613) 230-8821

PTO/SB/96 (6-98)
Approved for use through 09/30/2000 OMB 0651-0031
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Jason T. Sterne et al.

Application No./Patent No.: 5,818,839 Filed/Issue Date: October 6, 1998

Entitled: TIMING REFERENCE FOR SCHEDULING DATA TRAFFIC ON MULTIPLE PORTS

Alcatel Networks Corporation, a Corporation,
(Name of Assignee) (Type of Assignee, e.g , corporation, partnership, university, government agency, etc)

states that it is:

1. [x] the assignee of the entire right, title, and interest; or
2. [ ] an assignee of an undivided part interest

in the patent application/patent identified above by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

OR

B. [ ] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From: Inventors To: Newbridge Networks Corporation
   The document was recorded in the Patent and Trademark Office at
   Reel 8730, Frame 0243, or for which a copy thereof is attached.
2. From: Newbridge To: Alcatel Networks Corporation
   The document was recorded in the Patent and Trademark Office at
   Reel _____, Frame _____, or for which a copy thereof is attached.
3. From: _____ To: _____
   The document was recorded in the Patent and Trademark Office at
   Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[ ] Copies of assignments or other documents in the chain of title are attached.
[**NOTE**: A separate copy (*i.e.*, the original assignment document or a true copy of the original document) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded in the records of the PTO. See MPEP 302-302.8]

The undersigned (whose title is supplied below) is empowered to sign this statement on behalf of the assignee.

_____ Date

_____ Signature

_____ Typed or printed name

_____ Title

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Jason T. Sterne

For	:	*TIMING REFERENCE FOR SCHEDULING DATA TRAFFIC ON MULTIPLE PORTS*
Patent No.	:	**5,818,839**
Issued	:	October 6, 1998
Examiner	:	K. Vanderpuye
Art Unit	:	2732
Our File	:	**93698-US**

October 4, 2000

Hon. Commissioner of Patents
and Trademarks
Washington, D.C. 20231
U. S. A.

Sir:

PRELIMINARY AMENDMENT

This is a preliminary amendment to the reissue application of U.S. Patent 5,818,839. Please amend the specification by correcting the paragraph beginning at column 2 line 46 and continuing to column 3 line 2 as follows:

> The basic concept of calendar-based scheduling is illustrated in FIG. 1. Calendar scheduling is used in ATM applications to decide when to transmit a cell from a given connection. This scheduling is directly applicable to a shaping function. Time is generally referenced in cell times where one cell time is the time from when the first bit of one cell passes a reference point until the time when the first bit of the next cell passes the reference point. As an example, one cell time on an OC3 link is about 2.83 us. Each time the calendar current time is advanced, this is called a "tick". As the current time moves forward, based on some generated or provided timing reference, the current time will pass a connection's scheduled transmit time. These are virtual connections (VC) in

FIG. 1. When the current time passes a VC's scheduled time, then a cell from the VC will be transmitted, or placed in a transmit queue, and that VC will be rescheduled on the calendar for a later time. In FIG. 1 virtual channels (VC1 and VC2) are transmitting at the same speed while VC3 is at a slower data rate. Thus, as shown in FIG. 1, when the current time advances by a "tick" a cell is transmitted [from each VC and that VC is scheduled for a later time slot in the calendar] for the VC which his scheduled at that time.

IN THE CLAIMS

Please cancel issued claims 1 to 12.

Please add claims 13 to 23 as follows:

13. A communication system having a plurality of ports with respective data rates, each one of said ports being associated with a calendar having a plurality of successive calendar time slots for indicating data, or absence thereof, to be transmitted; a pointer pointing to one of the time slots; and a calendar clock pulse for effecting transmission of data, in accordance with the calendar time slot pointed to by the pointer, the transmission of data being onto the port associated with the calendar, and advancing the pointer to a next calendar time slot, the system comprising:

means for generating a master clock pulse at a rate greater than or equal to the highest of the respective data rates of the plurality of ports; and

means for deriving the calendar clock pulse for each calendar based on said master clock pulse, so as to have a rate not higher than the data rate of the port associated with the calendar.

14. A communication system as defined in claim 13, wherein said means for generating a master clock pulse relies on a clock signal received from the port having the highest data rate.

15. A communication system as defined in claim 14, wherein the rate of the calendar clock pulse for each calendar is approximately equal to the date rate of its associated port.

16. A communication system as defined in claim 15 having means to calculate an increment value and a tick threshold value based on the calendar clock pulse and data rate of each port and said means for deriving said calendar clock pulse for each calendar based on said master clock pulse further has:

a port counter having means to accumulate said calculated increment value;

means for generating said calendar clock pulse, if said accumulated increment value is lower than said calculated tick threshold value; and

means for decrementing said port counter by a predetermined decrement value, if said accumulated increment value is greater than or equal to said calculated tick threshold value.

17. A communication system as defined in claim 13, wherein said means for generating a master clock pulse generates a pulse n times faster than the date rate of the port having the highest data rate.

18. A communication system as defined in claim 17 wherein said means for deriving the calendar clock pulse for each calendar based on the master clock pulse further comprises;

a global counter that is incremented by one unit value for each master clock pulse; and

means for generating said calendar clock pulse and subsequently incrementing a port counter by a predetermined increment value if a value of said global counter is equal to or greater than said port counter.

19. A method for transmitting data on multiple ports having different data rates, each of said ports being associated with a calendar having a pointer pointing to one of a plurality of calendar time slots which indicate data, if any, to be transmitted, and a calendar clock pulse for triggering the transmission of said data, if any, onto one of said ports and thereafter advancing the pointer to a next calendar time slot, the method comprising the steps of ;

generating a master clock pulse having a rate that is equal to or greater than the data rate of the port having the highest data rate; and

deriving a calendar clock pulse based on the master clock pulse, such that the rate of transmission from the calendar is less than or equal to the data rate of the port associated with the calendar.

20. The method as defined in claim 19 wherein said master clock pulse is derived from the data rate of the port having the fastest rate.

21. The method as defined in claim 20 wherein the step of deriving a calendar clock pulse based on the master clock pulse further comprises;

incrementing a port counter by a predetermined increment value;

generating said calendar clock pulse if said port counter has a value lower than a predetermined tick threshold; and

decrementing said port counter by a predetermined decrement value if said port counter has a value greater than or equal to said predetermined tick threshold.

22. The method as defined in claim 21 wherein said master clock pulse is n times greater faster than the data rate of the port having the fastest data rate.

23. The method as defined in claim 22 wherein said step of deriving a calendar clock pulse based on the master clock pulse further comprises the steps of:

incrementing a global counter by a unit value; and

generating said calendar clock pulse, if said said global counter is greater than or equal to a port counter, and subsequently incrementing said port counter by a predetermined increment value.

STATUS OF CLAIMS AND SUPPORT FOR CLAIM CHANGES
(37 CFR 1.173 (c))

By this Preliminary Amendment issued claims 1 to 12 have been cancelled and claims 13 to 23 have been added.

Support for the added claims are as follows:

Claim 13 is supported in the patent beginning at column 2 line 46 to column 3 line 10.

Support for claim 14 is found at column 3 beginning at line 55.

Support for claim 15 is found at column 4 beginning at line 41.

Support for claim 16 is found at column 3 beginning with the paragraph at line 50.

Claim 17 is supported at column 4 line 46.

Claim 18 is supported at column 4 line 56.

Claims 19 through 23 are the method aspects of the system claims 13 through 18 and are supported by the sections indicated above.

Favorable consideration of this reissue application is respectfully requested.

Respectfully submitted,

George M. MacGregor, Reg. No. 37,547
Marks & Clerk
P.O. Box 957, Station B
280 Slater Street, Suite 1800
Ottawa, Ontario, Canada
K1P 1C2

Telephone No.: (613) 236.9561
Facsimile No.: (613) 230-8821

TIMING REFERENCE FOR SCHEDULING DATA TRAFFIC ON MULTIPLE PORTS

FIELD OF THE INVENTION

The present invention relates to the scheduling of data traffic to multiple output ports having different data rates and more particularly to the scheduling of such traffic utilizing a single timing reference.

BACKGROUND

The present invention will be described with reference to data traffic management in an asynchronous transfer mode (ATM) network for broadband communications but it is to be understood that the basic concept disclosed is applicable to any data traffic management device which services multiple output ports having different data transmission rates.

Asynchronous transfer mode (ATM) is a networking technology that provides broadband communications and differentiated qualities of service (QoS). The technology, which utilizes a fixed length cell, is well-suited to the transmission of voice, video and data utilizing both real-time and non-real-time service categories. Statistical multiplexing is used in ATM switches to allow for a high efficiency of resource utilization. In order to take advantage of the statistical nature of ATM traffic and still ensure some guaranteed QoS to network data it is important that the streams of ATM data conform to certain specific parameters. These parameters and the guaranteed qualities of service make up the traffic contract as established by the ATM Traffic Management Forum.

In ATM switches it is often useful and/or necessary to shape or schedule ATM cells from various traffic streams. This scheduling ensures that the traffic conforms to the specified parameters for each particular stream which leads to better overall network performance. There are applications where a shaping entity in an ATM system needs to schedule a mixture of traffic which is bound for several output ports. Each of these output ports may have a different data rate parameter. The requirement to service multiple data streams to output ports having different data rates requires or at least implies that the scheduling entity must adopt a different timing reference for each output port.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide systems and methods for scheduling data traffic onto several ports with each port having a different data rate using only a single timing reference as an input to the traffic scheduling device.

In a specific embodiment of the invention the systems and methods apply to an ATM communication network.

Therefore, in accordance with a first aspect of the present invention, there is provided in a data traffic management system having a plurality of output ports for servicing data traffic of different data rates and a scheduling device having a plurality of data calendars for shaping data traffic destined for each of said output ports, a single timing reference to schedule transmission of data to appropriate output ports. The single timing reference comprises timing means to generate a clock pulse based on the data rate of the output port having the fastest data rate; counter means to continually count the clock pulses following an initialization event; increment means to dynamically compare the accumulated number of clock pulses with predetermined increments for each calendar based on the data rate assigned thereto; and threshold means responsive to inputs from said increment means to control transmission of data traffic from each of said calendars.

In a first embodiment the clock pulse is equal to the data rate of the data traffic of the output port having the fastest data rate.

In this embodiment a first-in, first-out buffer is positioned in advance of the output port to absorb the bursty nature of the calendar output.

In accordance with a second embodiment the clock pulse is 'n' times faster than the data rate of the output port having the fastest data rate. It is anticipated that 'n' will be at least 10.

In accordance with a second aspect of the present invention there is provided a method of providing a timing reference to a data traffic management system, the system having a plurality of output ports each configured to transmit data at a different data rate and a scheduling device having a calendar for shaping data traffic for delivery to each of said output ports. The method comprises the steps of continually generating a clock pulse based on the data rate of the output port having the fastest data rate; counting the accumulated clock pulses following an initialization event; dynamically comparing the accumulated clock pulses with predetermined increment values for each calendar based on an assigned data rate for each calendar; and controlling transmission of data from the calendars from appropriate output ports in response to input signals generated by threshold means when the accumulated clock pulses and increment values reach a threshold respecting each calendar.

DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail with reference to the attached drawings wherein:

FIG. 1 represents a simple calendar operation for connection scheduling;

FIG. 2 is a block diagram showing a single timing reference according to a first aspect of the invention; and

FIG. 3 is a block diagram of a timing reference input according to a second embodiment.

DETAILED DESCRIPTION OF THE INVENTION

The basic concept of calendar-based scheduling is illustrated in FIG. 1. Calendar scheduling is used in ATM applications to decide when to transmit a cell from a given connection. This scheduling is directly applicable to a shaping function. Time is generally referenced in cell times where one cell time is the time from when the first bit of one cell passes a reference point until the time when the first bit of the next cell passes the reference point. As an example, one cell time on an OC3 link is about 2.83 us. Each time the calendar current time is advanced, this is called a "tick". As the current time moves forward, based on some generated or provided timing reference, the current time will pass a connection's scheduled transmit time. These are virtual connections (VC) in FIG. 1. When the current time passes a VC's scheduled time, then a cell from that VC will be transmitted, or placed in a transmit queue, and that VC will be rescheduled on the calendar for a later time. In FIG. 1 virtual channels (VC1 and VC2) are transmitting at the same speed while VC3 is at a slower data rate. Thus, as shown in FIG. 1, when the current time advances by a "tick" a cell is

transmitted from each VC and that VC is rescheduled for a later time slot in the calendar.

If a scheduling device is scheduling for several output ports, then a calendar will exist for each port. It is within the scope of the present invention to have a physical calendar for each port or a system which uses a single calendar to emulate the operation of multiple calendars. For each of the calendars, the cell time may be different because the data rate of each port may be different.

The difference in cell times means that the current time marker/indicator for each calendar will be moved forward at a different rate. For example the data rate of ATM cells on an OC3 link is 149.76 Mb/s which means that one cell time is 2.83 us. On a DS3 link (Direct Mapped), the data rate is 44.21 Mb/s which means that one cell time is 9.59 us. Consequently, a calendar that services an OC3 link would step the current time marker forward once every 2.83 us while a calendar that services a DS3 link (Direct Mapped) would step the current time marker forward once every 9.59 us.

The present invention provides two separate embodiments relating to systems and methods for using a single time source to schedule traffic onto multiple ports wherein the data rate of each port is different.

The first embodiment is shown in a block diagram of FIG. **2**. As shown a plurality of output ports, **12, 14, 16,** are shown and further identified as port **1**, port **2** and port n. Each port includes a FIFO **18** for queuing and transmitting data traffic according to the data rate of the particular port. Each port continuously monitors the data rate of the data being transmitted therefrom and this data rate information is provided to Clock Selection Device **20** via lines **22**. Clock Selection Device **20** monitors each of the data rates and selects the fastest rate to provide a master clock pulse to Data Scheduling Device **24**. As shown in FIG. **2** Scheduling Device **24** includes calendars **26, 28** and **30** wherein each calendar shapes data traffic for port **1**, port **2** and port n respectively.

For every clock event received by the Scheduling Device **24** a decision must be made for each calendar as to whether that calendar should be "ticked" or advanced. To decide whether to advance each of the calendars a counter, an increment device, and a threshold device are used. Each calendar has the following values associated with it:

1) Counter,
2) Tick_Increment,
3) No_Tick_Threshold.

The Counter is initialized to zero and the other two parameters are initialized to specific values that are calculated based on the port speed associated with the calendar and also on the port speed of the fastest port. This is necessary since the fastest port provides the Master Cell Tick **32**.

Whenever a Master Cell Tick occurs each calendar will add Tick_Increment to the Counter. As long as the Counter is less than the No_Tick_Threshold then the calendar is ticked and a cell is sent to the port associated with the Counter. When the Counter is greater than or equal to the No_Tick Threshold then the value of Counter is decremented by the value of No_Tick_Threshold and the calendar is not ticked.

The following is a pseudo-code that illustrates the algorithm described above:

```
Service_Tick_Begin:
    for each calendar
      Counter = Counter + Tick_Increment
      if Counter >= No_Tick_Threshold
        Counter = Counter - No_Tick_Threshold
      else
        tick the calendar & send a cell
      endif
    next
Service_Tick_End
```

For the calendar that is servicing the fastest port, Tick_Increment will be zero and No_Tick_Threshold will be set to one. These values will ensure that the calendar is ticked for every Master Cell Tick.

For all the other calendars which are servicing ports that are slower than the reference provided by Master Cell Tick, values for Tick_Increment and No_Tick_Threshold must be chosen in a manner that ensures that the calendar is occasionally not ticked when a Master Cell Tick occurs. Thus, for every Master Cell Tick, one calendar (the fastest port) will tick but all the other calendars will go through a cycle that looks like: tick-tick-tick-tick-no tick-tick-tick-tick-tick-no tick. This occasional "no tick" has the effect of lowering the effective rate at which the calendar is being ticked.

Given the port rate for the fastest port and the rate of the port that a particular calendar is servicing, appropriate values for Tick_Increment and No_Tick_Threshold can be chosen so that the effective cell rate out of the calendar scheduling is equal to the cell rate of that port. The values used for all the calendar parameters should be in a representation that supports fractional values for better accuracy. FIFOs at each port are required to absorb the bursty nature of the calendar servicing created by this method.

In this manner, all calendars (that may service ports with different rates) can be effectively ticked at their appropriate rate using only the single timing input called Master Cell Tick. A given calendar will be ticked several times at the fastest rate, and then pause for a tick, and then tick again at the fastest rate, and then pause for a tick, and so on.

The second embodiment of the present invention is shown in FIG. **3**. In this embodiment the same output ports **12, 14** and **16** and FIFO **18** are illustrated. In this embodiment, however, the Clock Selection Device is not used but rather a Master Clock **42** which is 'n' times faster than the cell rate of the fastest output port is provided to scheduling device **24**. In a preferred embodiment the value of n is 10 or more. As an example, if the fastest cell rate is 100,000 cells per second, then the Master Clock Rate would be 1 Mhz or 1,000,000 clocks per second.

The Master Clock is used to decide when to tick (and thus send a cell) each of the calendars managed by the scheduling device. In essence, each calendar will be scheduled by using the Master Clock and two per-calendar parameters. A counter that may be called Global Time is incremented by one for each Master Clock event. Thus, Global Time will continually increment at a rate at least 10 times faster than the cell rate of the fastest port.

Each calendar has the following values associated with it:

1) Increment,
2) Next_Tick_Time.

The Global Counter is initialized to zero and Next_Tick_Time for each calendar is set equal to its calendar Increment.

For every Master Clock event, the Global Time value will increase. Each calendar will then compare its Next_Tick_Time to the Global Time. If the Global Time has passed the

Next_Tick_Time, then that particular calendar must be ticked. The Next_Tick_Time will then be incremented by the Increment, which essentially schedules the calendar again for some time in the future. The Increment for each calendar is chosen based on the rate of the Master Clock and the rate of the port that the calendar services. Each calendar Increment can be chosen so that the calendar is ticked at the cell rate of the port.

Here is some pseudo-code that illustrates the algorithm described above:

```
Service_Master_Clock_Event_Begin:
    Global_Time = GlobalTime + 1
    for each calendar
      if Global_Time >= Next_Tick_Time
          tick the calendar & send a cell
          Next_Tick_Time = Next_Tick_Time + Increment
      endif
    next
Service_Master_Clock_Event_End
```

With this method, all the calendars servicing ports with different data rates can be ticked at their appropriate cell rate, using only the single input timing reference.

While particular embodiments of the invention have been described and illustrated it will be apparent to one skilled in the art that still other variations to the basic concept can be implemented. It is to be understood that such variations will also fall within the scope of the invention as defined by the appended claims.

We claim:

1. In a data traffic management system having a plurality of output ports for servicing data traffic of different data rates and a scheduling device having a plurality of data calendars for shaping data traffic destined for each of said output ports, a single timing reference to schedule transmission of data to appropriate output ports comprising:

timing means to generate a clock pulse based on the data rate of the output port having the fastest data rate;

counter means to continually count the clock pulses following an initialization event;

increment means to dynamically compare the accumulated number of clock pulses with predetermined increments for each calendar based on the data rate assigned thereto; and

threshold means responsive to inputs from said increment means to control transmission of data traffic from each of said calendars.

2. A timing reference as defined in claim **1** wherein said clock pulse is equal to the data rate of the data traffic of the output port having the fastest data rate.

3. A timing reference as defined in claim **2** wherein said threshold means controls said calendar means to prevent transmission of data traffic in response to an input from said increment means.

4. A timing reference as defined in claim **1** further comprising a first-in first-out buffer between said calendars and said output ports.

5. A timing reference as defined in claim **1** wherein an input from said increment means causes said counter means to be re-initialized.

6. A timing reference as defined in claim **1** wherein said clock pulse is n times faster than the data rate of the output port having the fastest data rate.

7. A timing reference as defined in claim **6** wherein said threshold means controls said calendar means to transmit data traffic in response to an input from said increment means.

8. A timing reference as defined in claim **7** wherein said clock pulse is at least 10 times faster than the data rate of the fastest output port.

9. A method of providing a timing reference to a data traffic management system, the system having a plurality of output ports each configured to transmit data at a different data rate and a scheduling system having a calendar for shaping data traffic for delivery to each of said output ports, the method comprising:

continually generating a clock pulse based on the data rate of the output port having the fastest data rate;

counting the accumulated clock pulses following an initialization event;

dynamically comparing the accumulated clock pulses with predetermined increment values for each calendar based on an assigned data rate for each calendar; and

controlling transmission of data from said calendars to appropriate output ports in response to the accumulated clock generated by threshold means when the accumulated clock pulses and increment value reaching a threshold respecting each calendar.

10. A method as defined in claim **9** wherein the clock pulse equals the fastest data rate and the data transmitted from the output ports is controlled such that no data is transmitted in response to an input signal.

11. A method as defined in claim **9** wherein the clock pulse rate is 'n' times faster than the fastest data rate and the data transmitted from the output port is controlled such that data is transmitted in response to an input signal.

12. A method as defined in claim **11** wherein 'n' is at least 10.

* * * * *

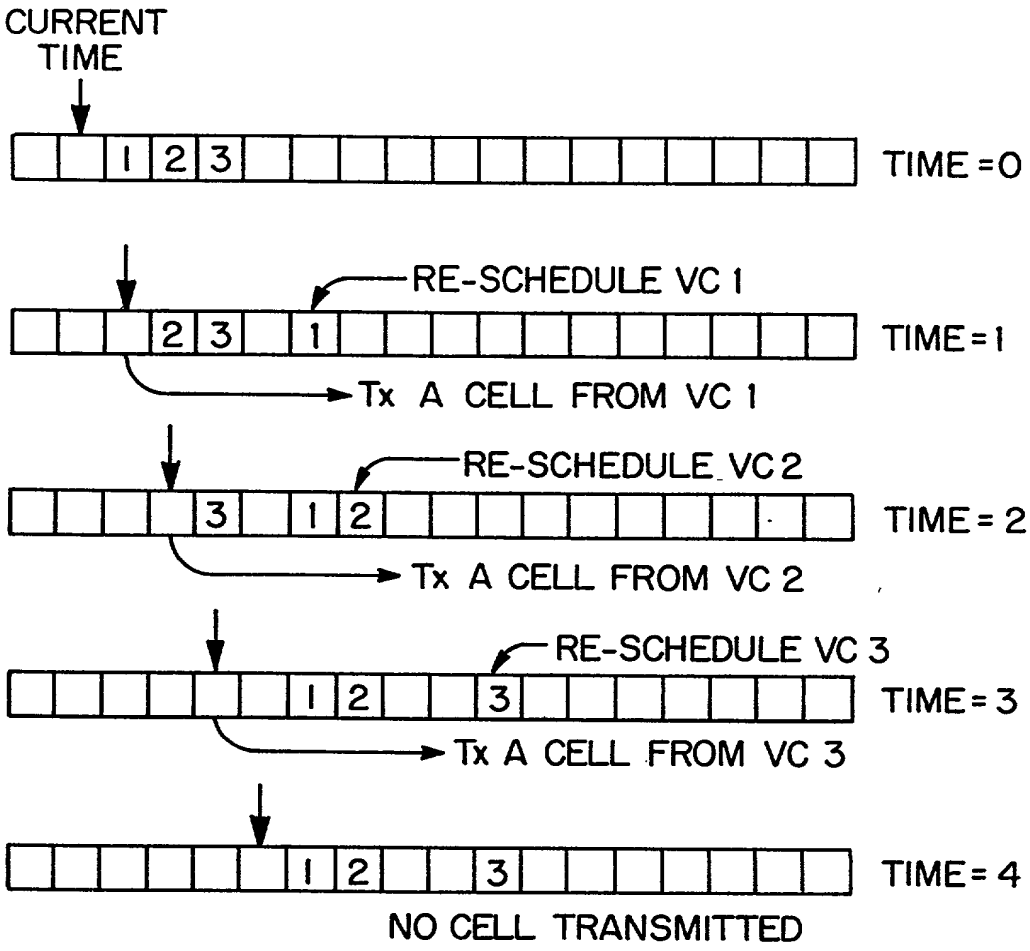
CURRENT
TIME
1
2
3
TIME = 0
RE-SCHEDULE VC 1
TIME = 1
Tx A CELL FROM VC 1
RE-SCHEDULE VC 2
TIME = 2
Tx A CELL FROM VC 2
RE-SCHEDULE VC 3
TIME = 3
Tx A CELL FROM VC 3
TIME = 4
NO CELL TRANSMITTED

FIG. 1

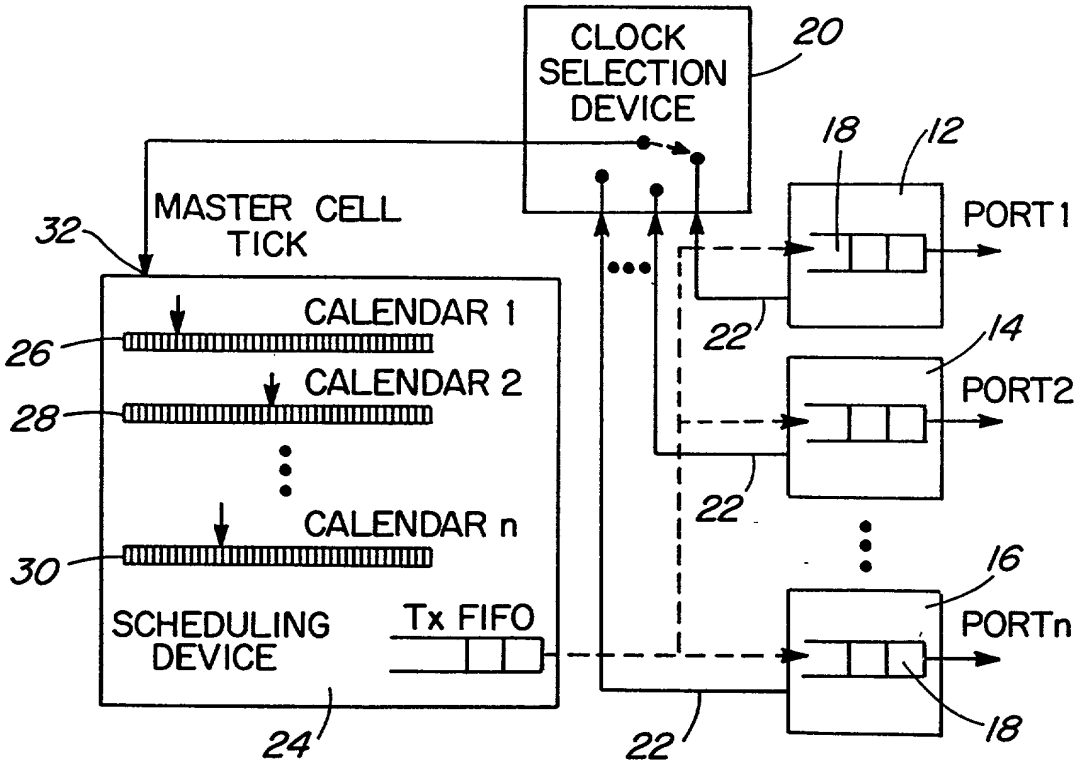
CLOCK SELECTION DEVICE
20
MASTER CELL TICK
32
CALENDAR 1
26
CALENDAR 2
28
CALENDAR n
30
SCHEDULING DEVICE
Tx FIFO
24
22
18
12
PORT1
14
PORT2
16
PORTn

FIG. 2

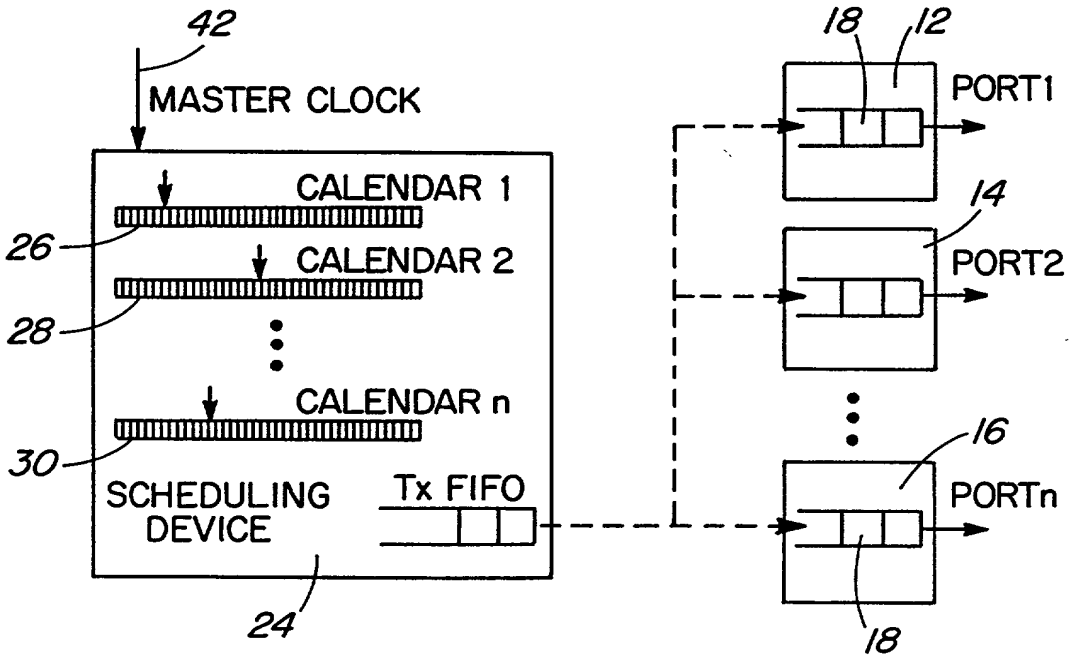
42
MASTER CLOCK
CALENDAR 1
26
CALENDAR 2
28
CALENDAR n
30
SCHEDULING DEVICE
Tx FIFO
24
18
12
PORT1
14
PORT2
16
PORTn

FIG. 3

PTO/SB/51 (12-97)
Approved for use through 9/30/00. OMB 0651-0033
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

REISSUE APPLICATION DECLARATION BY THE INVENTOR	Docket Number (Optional) 93698-US

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are stated below next to my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is described and claimed in patent number 5,818,839, granted October 6, 1998, and for which a reissue patent is sought on the invention entitled TIMING REFERENCE FOR SCHEDULING DATA TRAFFIC ON MULTIPLE PORTS,
the specification of which

[X] is attached hereto.

[ ] was filed on _____ as reissue application number ___ / _____
and was amended on _____ .
(If applicable)

I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.
I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.
I verily believe the original patent to be wholly or partly inoperative or invalid, for the reasons described below. (Check all boxes that apply.)

[X] by reason of a defective specification or drawing.

[X] by reason of the patentee claiming more or less than he had the right to claim in the patent.

[ ] by reason of other errors.

At least one error upon which reissue is based is described as follows:

The specification in the issued patent is defective at column 3, line 1 in that a cell is transmitted from the VC which is scheduled at that time and the statement "that VC is rescheduled for a later time slot in the calendar" is in error.

Additionally the patentee claimed less than he had the right to claim in the patent.

PTO/SB/51 (12-97)
Approved for use through 9/30/00. OMB 0651-0033
Patent and Trademark Office, U S DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

(REISSUE APPLICATION DECLARATION BY THE INVENTOR, page 2)

Docket Number (Optional) 93698-US

All errors corrected in this reissue application arose without any deceptive intention on the part of the applicant. As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Name(s)	Registration Number
George M. MacGregor	37,547
Richard Mitchell	34,519

Correspondence Address: Direct all communications about the application to:

☐ Customer Number [ ] → *Type Customer Number here*

OR

Place Customer Number Bar Code Label here

☒ Firm or Individual Name	Marks & Clerk				
Address	P.O. Box 957				
Address					
City	Ottawa	State	Ontario	ZIP	K1P 5S7
Country	Canada				
Telephone	613 236 9561	Fax	613 230 8821		

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and imprisonment, or both, under 18 U.S.C. 1001, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this declaration is directed.

Full name of sole or first inventor (given name, family name)
Jason T. Sterne
Inventor's signature

Residence	Date
Post Office Address	Citizenship

Full name of second joint inventor (given name, family name)
David W. Carr

Inventor's signature	Date
Residence	Citizenship
Post Office Address	

Full name of third joint inventor (given name, family name)
Joey M.W. Chow

Inventor's signature	Date
Residence	Citizenship
Post Office Address	

☐ Additional joint inventors are named on separately numbered sheets attached hereto.